Circular No. 30 **Extension Service**

SUGGESTIONS ON THE

Treatment of Alkali Soils

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Showing skunk grass growing on an alkali spot in a field of oats on the College Farm. Also showing method followed in collecting soil samples

DEPARTMENT OF SOILS

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The Treatment of Alkali Soils

As more intensive farming is practised in Manitoba, the question of bringing small areas of alkali land into proper condition for profitable crop production must receive attention. A few alkali spots of from one to five acres in extent on a good farm are objectionable. First, because they reduce the average yield; secondly, the irregular shaped field is undesirable; thirdly, the weeds grow in such places, as shown in the front page illustration; and fourthly, on account of the weeds, the selling value of the farm will be reduced to a certain extent.

The suggestions outlined in this circular are not for the large areas of alkali land, but for the small spots, varying in size from a few square feet to five acres in extent, that are sometimes found on otherwise excellent farms.

Origin

The term, alkali soil, as commonly used, means a soil containing so much **soluble salt** that it will not produce a profitable crop. In all parts of the world where the annual rainfall is less than twenty-five inches, soils so charged with soluble salts that plants cannot grow upon them are found, and these soils are known as alkali soils. They are simply the result of the conditions under which they were formed, namely: first, a light rainfall, not sufficient to wash out the soluble salts as is done in the humid districts; second, poor drainage, allowing the water to gather in low places; and third, the excessive surface evaporation that takes place in semi-arid districts, bringing all the soluble salts to the surface in a more or less concentrated condition, where they are most injurious to crops when the plants are young and tender. As a rule these soils when properly reclaimed are as productive as the surrounding soils of the same origin.

Two Classes of Alkali

There are two classes of alkali, "white" and "black," so named on account of the color given the soil. The white alkali is the class commonly found in Manitoba, and it is largely due to the accumulation of common salt, Glauber's salt and Epsom salt, which give the soil a white color when dry. Black alkali is far more injurious to plants, and is due to the presence of sodium carbonate (washing soda) along with the salts found in white alkali. The sodium carbonate dissolves the vegetable matter in the soil and gives the soil water a dark brown or coffee color. As many factors enter in to alter the amount of soluble salt which may be present in a soil without injuring a crop, no attempt will be made in this circular to state the amounts of different salts that must be present in a soil to class it as alkaline.

rows the required distance apart, and regulating the drill to plant the seeds at the desired rate in the rows. If conditions are favorable the seeding should be done as soon as possible after a heavy rain, the rain tends to wash the salts down from the surface. The crop should receive plenty of surface cultivation during the summer to kill the weeds and prevent surface evaporation. The roots should be pulled in the fall before the frost and the tops cut off not too short. The beets make an excellent succulent winter feed for all classes of stock and especially for dairy cattle. It is sometimes necessary to raise a beet crop the second year on bad alkali spots, but usually it is well to plow in the fall just after harvesting the crop of beets and try a grain crop the following year. Mangels will usually give about as good returns as sugar beets on alkali soils.

After such treatment the land can usually be handled the same as the rest of the field, keeping in mind that **deep preparation** and **thorough cultivation** are essential in keeping alkali soils in a productive condition. Out of one-hundred-and-fifty students that have reported on alkali soils in the past two years, about 70 per cent have mentioned some such treatment as outlined above, and in 80 per cent of the cases favorable results were obtained.

Results obtained during the past few years tend to show that barley will stand more alkali than oats, but sometimes the reverse is true. This may be due to the presence of different salts. Rye and flax will stand practically the same amount as barley, while wheat is more sensitive to alkali than any of the crops named above.

Alfalfa when once established on alkali soil will give good returns, but it is not advisable to try alfalfa as it is very difficult to obtain a catch on alkali land. On the other hand alfalfa will not stand an acid soil, a portion of one field on the College farm seeded to alfalfa this year failed because the soil was acid.

Sweet clover is said to stand a large amount of alkali, and it is being tried this year at the College, but no statement can be made yet.

General

Any method of treatment which will tend to increase the humus in an alkali soil will aid. One method is to thresh straw upon the small alkali spots and allow the stock to feed around the straw stacks. The bottoms of the stacks are then scattered and plowed under, or as much of the straw as possible is burned and the rest plowed under. The straw acts the same as the manure, and the spots are cropped as mentioned above. Sometimes where a grain crop has been killed out, if later in the season the moisture content is right, a crop of millet, rye or rape may be seeded, and later in the season plowed under as a green manure.

Cultivation

After the best possible drainage has been secured, a heavy application of strawy manure should be made at the rate of from fifteen to twenty tons per acre during the summer or early fall. The manure has three beneficial effects; first, it makes the soil more open and porous, allowing better drainage, preventing both puddling and baking; second, it will act somewhat like a mulch, preventing surface evaporation and rising of the soluble salts to the surface of the soil; third, it will supply the young crop with available plant food in the spring, when the alkali soil, which is inclined to be cold and dead, will not.

Plow the land in the summer as deep as the sub-soil will permit, use the cultivator and harrow as on a summer fallow. This will leave the soil exposed to the action of the rain and snow during the fall and winter, which will tend to improve the soil for the following year. In the spring, as soon as the land is dry enough to permit, surface cultivation should be followed, either with the cultivator, disc, or spike-tooth harrow, to prevent surface evaporation and form the best possible seed bed for the crop. Thorough cultivation must always be maintained upon alkali soil. If there is a hard-pan under the alkali soil so that it cannot be plowed deep the first year, the depth should be increased about half an inch each year until a depth of eight inches is reached.

The Choice of Crops

Experiments have proven conclusively that plants differ widely in their ability to withstand alkali. The desired crop is one that will aid in removing the salts and at the same time give a profitable return. The amount of salt removed by the average crop compared with that present in the soil is very small. The chief benefit results from the cultivation, the manure and the crop all tending to keep the salts from coming to the surface of the soil.

Of the cultivated crops, sugar beets will stand the most alkali and give satisfactory returns. They are an inter-tillage crop, being cultivated between the rows like corn, thus keeping a surface mulch on the ground. The beets absorb a certain amount of the soluble salts, and the salts are removed in this way. Sometimes the first crop of beets on alkali soil will absorb so much salt that cattle will refuse to eat them, and if forced to eat the beets the effect is the same as a laxative.

In Manitoba, sugar beets are planted from May 15th to June 1st at the rate of four pounds of seed per acre, at a depth of an inch and a half, in rows thirty to thirty-six inches apart and seven to nine inches apart in the row. The Danish sugar beet is a good variety, and should yield from 400 to 500 bushels per acre. The seeding can be done by using the common grain drill, mixing one-third seed with two-thirds barley chop by volume, stopping up the tubes in the drill to make the

Harmful Effects of Alkali

It is a well known fact that all plants take their food from the soil in the form of a weak solution. In alkali soils the soluble salts make the solution so strong that plants cannot take up the moisture, and in some cases the plants actually give up moisture to the soil and die. Hence we often find that alkali is the most injurious in seasons having fairly good spring rains followed by a dry summer. The spring rains dissolve a large amount of the salts, then during the dry summer excessive surface evaporation takes place, bringing the salts up into the root zone in a concentrated condition, causing the plants to quickly succumb to the drouth.

Alkali, and especially black alkali, tends to destroy the structure of a soil, breaking down the granular friable condition, causing the soil to become impervious to water, puddle when wet, and bake in large clods when dry. Hence, as a rule it is very difficult to work such soils.

Black alkali dissolves the humus in the soil, and corrodes and eats away the stems of the plants at the surface of the ground. This is apt to occur when the plants are young, but may take place any time during the season.

Treatment

There is no royal road to success when it comes to treating alkali soil. Many ways of handling alkali soils have been tried in the past with varying results. Methods quite successful in one locality have proven utter failures when tried in other districts. Black alkali may be changed to white by applying gypsum, land plaster ($CaSO_4$) to the land at the rate of from 1000 to 3000 pounds per acre. Then it can be treated as white alkali. Land plaster costs $7.00 a ton at Winnipeg. Up to the present time no chemical means of treating white alkali has proven practical.

Drainage

The only sure way of treating alkali is by drainage. Either open or under drainage is the first step [illegible] treatment. While the land may appear to be well drained, all available [illegible] prove that proper drainage is the most vital point in every case. [illegible] the College farm this spring (1915) **no crops on tile drained land** have been injured by alkali, but on similar soil **undrained, alfalfa, oats, mangels, and sugar beets** killed out in places. For further advice on drainage write for circular on Soil Drainage.

In many cases a few open ditches will remove the surface water in the spring and reduce the harm done by alkali. Sometimes most of the alkali is in the sub-soil and open ditches will [illegible] remove it.

Summary

1. Alkali soils contain an excess of soluble salts.

2. They are caused by lack of rainfall, poor drainage and surface evaporation.

3. There are two classes, "black" and "white."

4. At the present time there is no practical chemical means of treating white alkali.

5. Provide the best possible drainage either open or tile.

6. Make heavy applications of manure to add humus.

7. Plow deep and cultivate thoroughly.

8. Crop with sugar beets or mangels.

9. Any one wishing to have soil tested or aid in drainage, apply to the Department of Soils, Manitoba Agricultural College.

Showing the operation of laying a tile drain. This is the surest method of removing alkali. The soluble salts are washed down and carried away through the drain